Asian Transport Outlook

CLEAN AIR ASIA

Have we made any progress on transport related air pollution in Asia?

2024

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INTRODUCTION

Transport-related air pollution emissions are a critical challenge that demands immediate attention, especially considering today's pressing environmental concerns and the urgent need for sustainable solutions. The relentless growth of passenger and freight transport demand has led to a surge in emissions that directly contribute to poor air quality, public health problems, and climate change.

This knowledge product examines the central question: "**Have we made any progress towards reducing transport-related air pollution in Asia**?"

We delve into a comprehensive analysis of the current state of Asia's transport-related air pollution, assessing the trends, initiatives, policies, technologies, and behavioral shifts undertaken in the ongoing quest for cleaner and more sustainable transportation options.

Furthermore, we examine reported traffic emissions, air pollution effects, and co-benefits of urban transport policies worldwide, emphasizing the need to track their impact for better policy development in Asia and beyond.

This knowledge product originates from the transport data and policy information collected in the Asian Transport Outlook (ATO) initiative and was co-developed with Clean Air Asia. The ATO is a transport observatory by the Asian Development Bank (ADB) and Asia Infrastructure Investment Bank (AIIB) to build a comprehensive knowledge base on transport in Asia and the Pacific region. The ATO is an open transport data and policy resource covering 51 economies using about 650 indicators at national and urban level. The ATO supports the planning and delivery of ADB transport support to the region, is a resource for regional governments to plan their transport sectors and tracks the implementation of the 2030 Sustainable Development Goals (SDGs), the Paris Agreement on Climate Change, and other international agreements.

Clean Air Asia is an international non-governmental organization leading the regional mission for better air quality, and healthier, more livable cities throughout Asia. Its mission is to reduce air pollution and greenhouse gas emissions in Asia and contribute to the development of a more sustainable, equitable and healthier region. The Asian Development Bank, the World Bank and USAID launched the Clean Air Initiative for Asian Cities (later becoming Clean Air Asia) as Asia's leading air quality network in 2001 in response to increasing air pollution across cities in Asia. Clean Air Asia promotes better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse emissions from transport, energy, and other sectors.

TRANSPORT AIR POLLUTANT EMISSION TRENDS

Asian Transport Outlook

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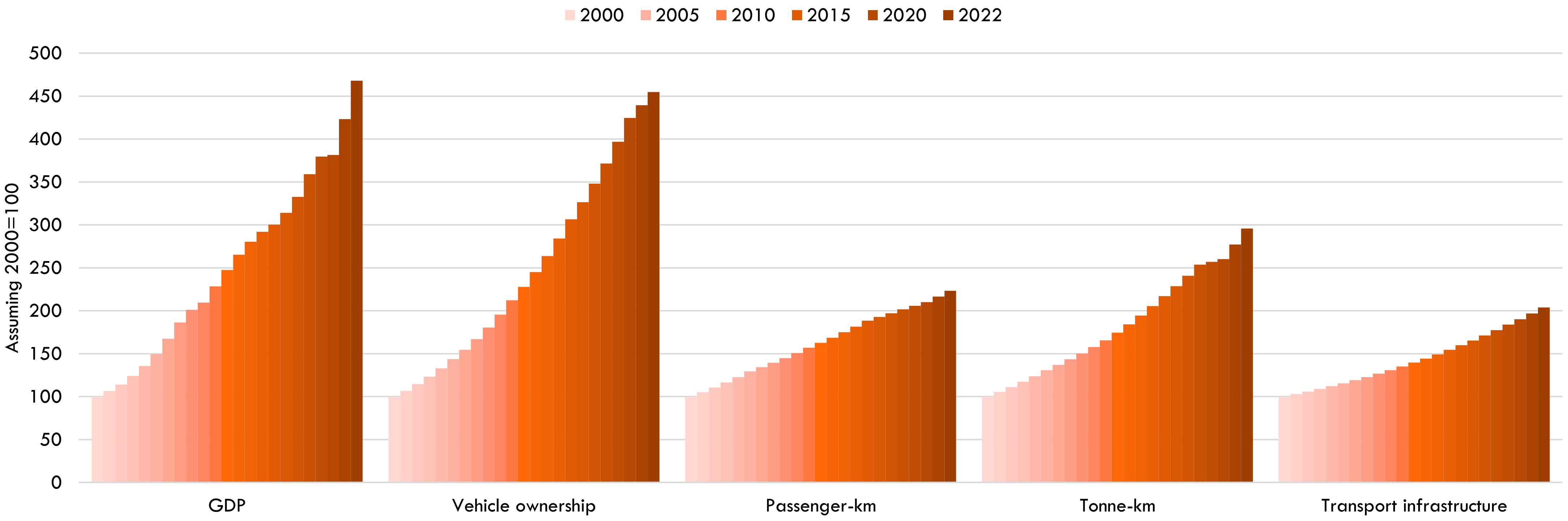
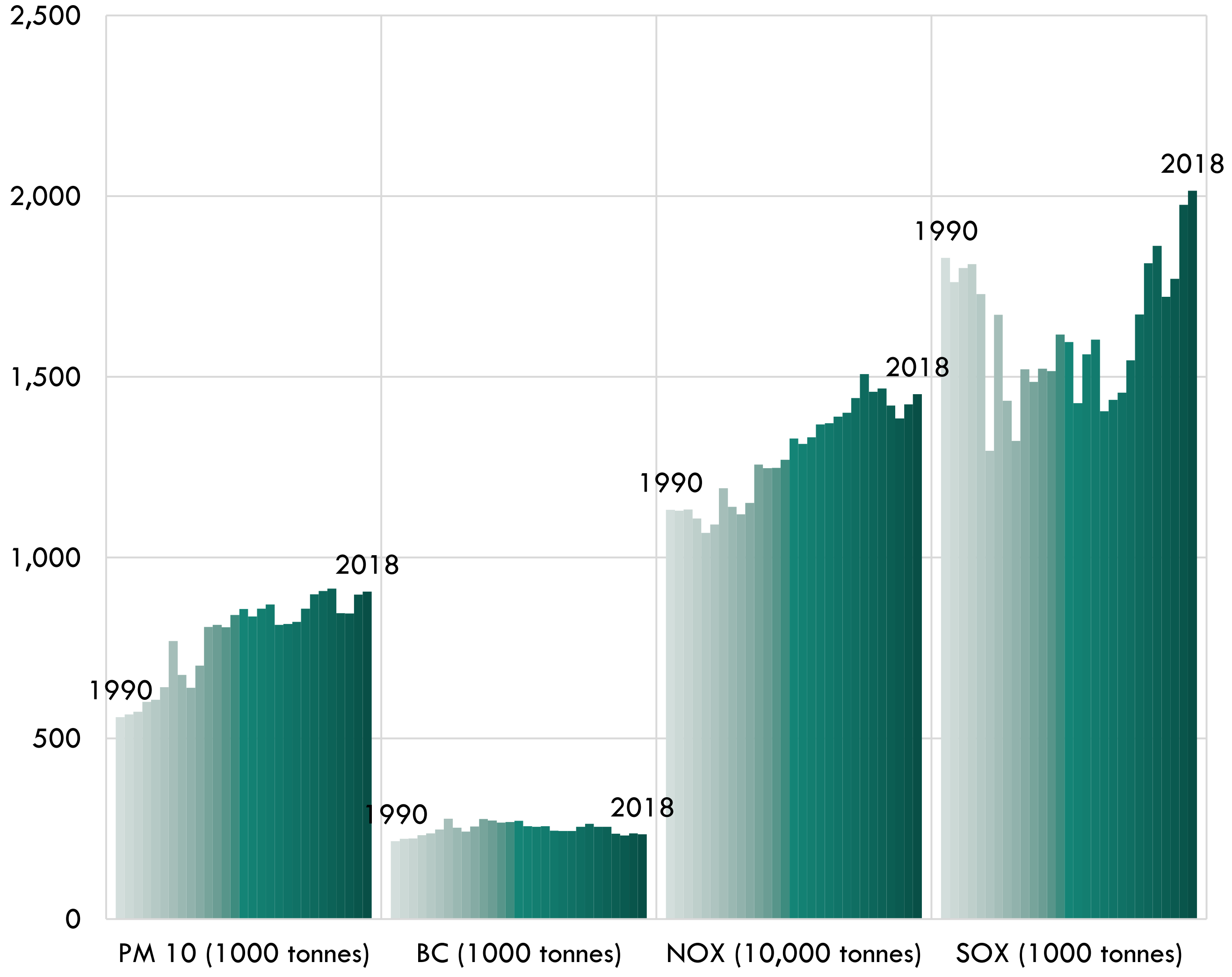
EXAMINING THE MULTIFACETED DRIVERS OF AIR POLLUTION EMISSIONS IN ASIA



The key drivers for road air pollution emissions are intricately connected to various factors, including GDP, vehicle ownership, transport demand, and infrastructure growth. As a country's GDP grows, there is often a corresponding increase in economic activity and income levels, leading to higher vehicle ownership rates, demand for transportation services, and increased road usage. Simultaneously, infrastructure growth, such as the construction of new roads and highways, attempts to accommodate this heightened demand. It is important to note that the relationship between these four factors and road air pollution emissions is complex and multifaceted. Considering the growth in the drivers, evidence suggests that air pollutant emissions with sustained reduction over the last decade have decoupled with economic and transport demand drivers at a regional level. However, the regional trends are influenced by a few countries, and individual country performance could be different.

Source: ATO analysis based on various sources. Please see the following ATO indicators: SEC-SEG-001, TAS-VEP-015 , TAS-VEP-016 , TAS-VEP-017 , TAS-VEP-018 , ,TAS-VEP-019 , TAS-VEP-020 , SEC-DEV-001, TAS-PAG-001 , TAS-FRA-001 , INF-TTI-005

TRANSPORT AIR POLLUTANT EMISSIONS



According to the latest Emissions Database for Global Atmospheric Research (EDGAR)* release, transport air pollutant emissions (PM10, NOx, BC, SOx) have increased over time.

Since 1990, the transport sector's

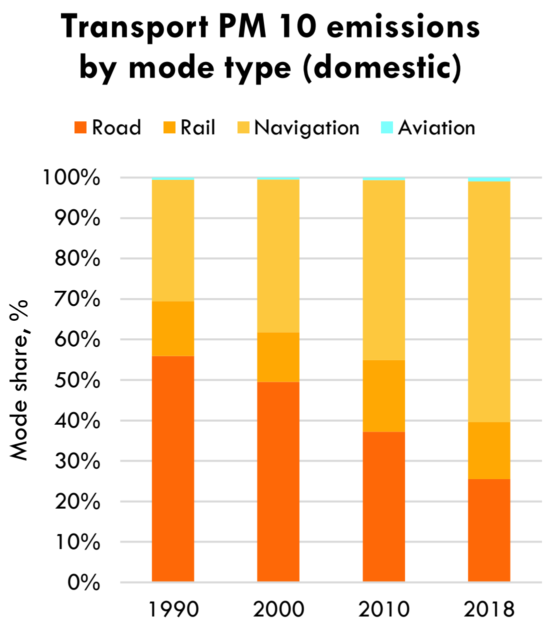
- Particulate Matter (10 micrometers or less in diameter), i.e., PM10 emissions increased by **62%**
- Black Carbon i.e., BC emissions increased by **9%**
- Nitrogen Oxides (NOx) emissions increased by **28%**
- Sulfur Oxides (SOx) emissions increased by **10%**

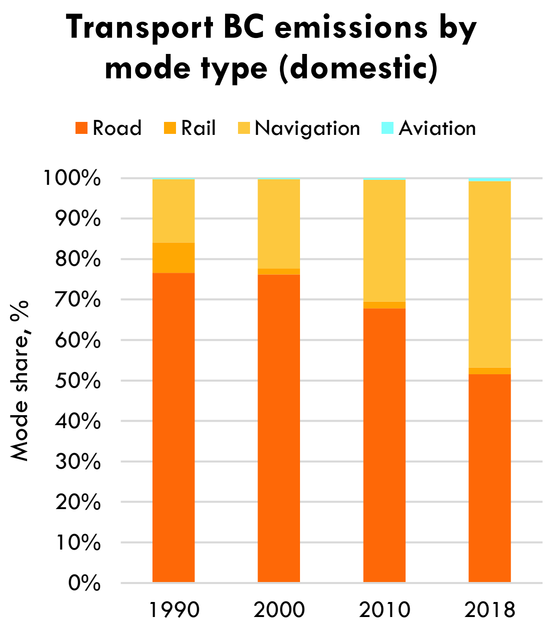
However, not all modes have contributed to the increase in air pollutant emissions.

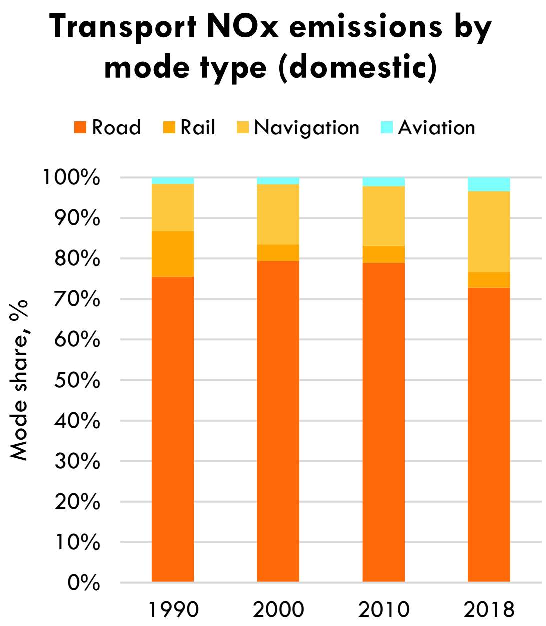
*The EDGAR database provides estimates of human-caused emissions and how they change over time. It is based on publicly available data and is used by scientists and policymakers. The database generates emissions by multiplying activity data with the corresponding emission factors for relevant source categories

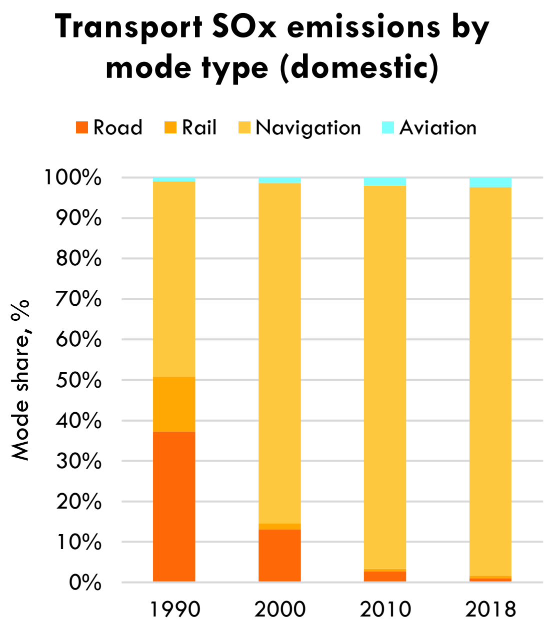
Source: ATO analysis based on the EDGAR Database. See the following: APH-VAP-001 , APH-VAP-002 , APH-VAP-003 APH-VAP-004

TRANSPORT AIR POLLUTANT EMISSIONS MODE SHARE







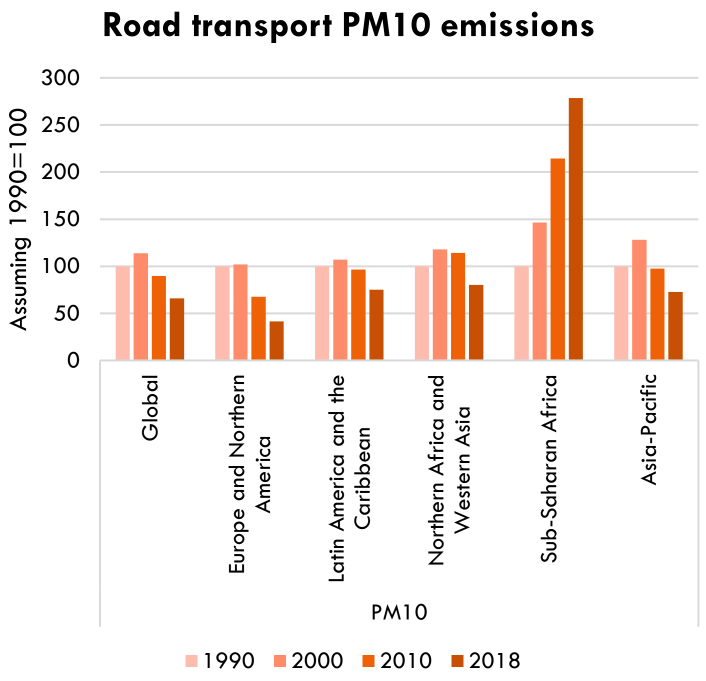


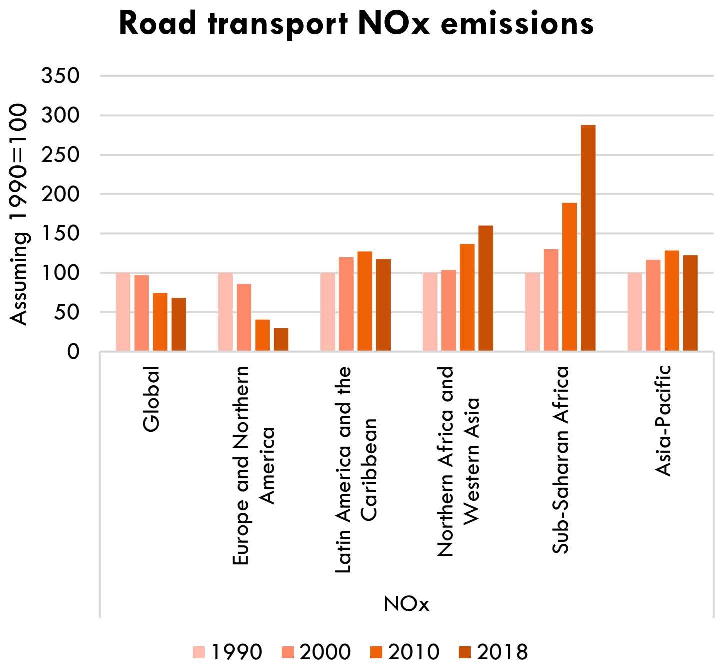
The contribution of various transport sub-modes to air pollution varies by region and transport activity. There is an inconsistent trend in emissions growth across different modes in Asia. Historically, road transport has been the most significant contributor to air pollution, but it has shown significant reductions in emissions (except for NOx) due to the implementation of vehicle emission standards, improved fuel quality, and supportive policies. On the other hand, emissions from domestic waterways and inland shipping have increased notably in this period.

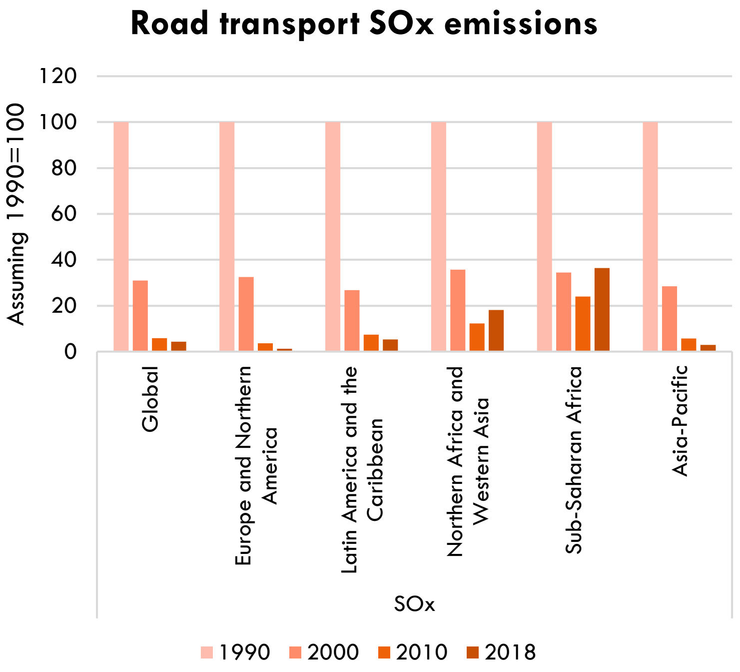
It's worth noting that data for transport emission modeling remains limited, particularly for domestic vessel activity in inland waterways and domestic shipping. As a result, the knowledge product primarily focuses on road transport, which has better data than other modes, caters to the predominant transport demand and more importantly has the highest health impact. We consider other modes where data or policy insight is available.

Source: ATO analysis based on the EDGAR Database. See the following: APH-VAP-001 , APH-VAP-002 , APH-VAP-003 APH-VAP-004, APH-VAP-006 , APH-VAP-007, APH-VAP-008 , APH-VAP-009 , APH-VAP-011 , APH-VAP-012, APH-VAP-013, APH-VAP-014, APH-VAP-016 , APH-VAP-017, APH-VAP-018, APH-VAP-019

DOMINANT SOURCE, DECLINING TREND: ASIA'S TRANSPORT EMISSIONS





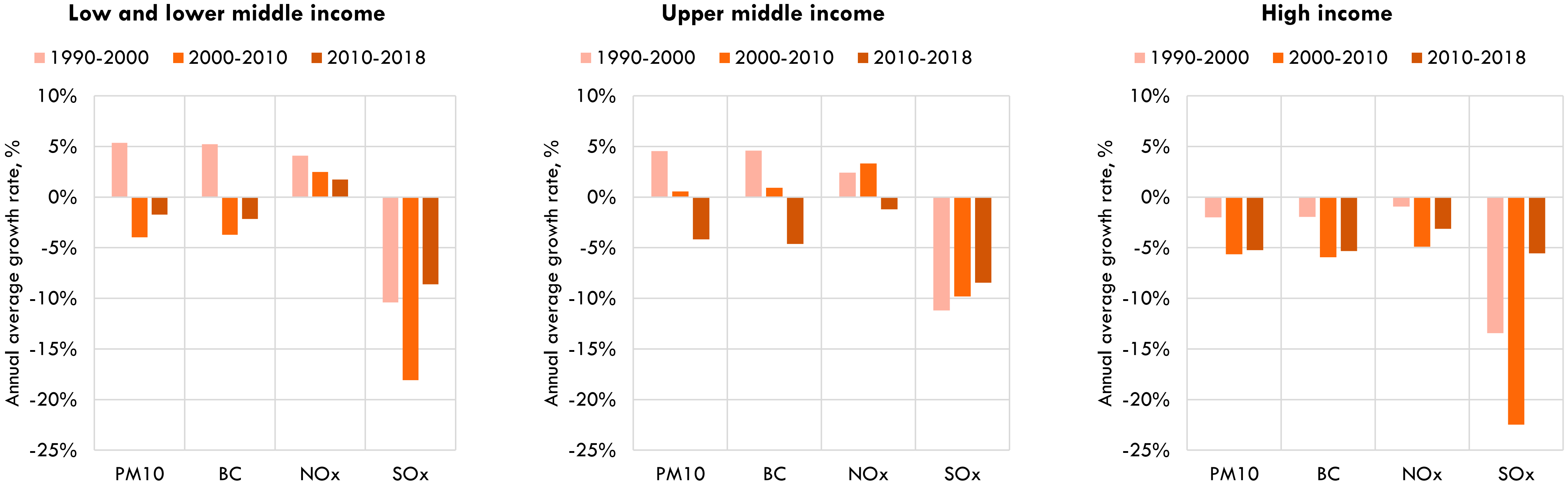


Asia and the Pacific hold a significant but decreasing global road transport air pollution share. In 2018, the region contributed 33%, 41%, and 19% of global road transport emissions for PM10, NOx, and Sox, respectively.

Notably, between 1990 and 2000, air pollutant emissions from road transport in Asia, particularly Eastern and Southeast Asia, outpaced growth in other sectors. However, a positive shift has emerged since 2000. Implementing stricter road transport regulations has helped curb air pollutant emissions despite the ongoing expansion of motor vehicles in the region. This progress is evident in the annual growth rates between 2000 and 2015, with PM10 and NOx emissions from road transport decreasing by 3% and 0% respectively. Since adopting the Sustainable Development Goals (SDGs) in 2015, the decline has accelerated, with PM and NOx emissions dropping by -5% and -1% annually. This marks the most significant reduction in road transport air pollution emissions among all regions globally.

Source: ATO analysis based on the EDGAR Database. See the following: APH-VAP-001 , APH-VAP-002 , APH-VAP-003 APH-VAP-004, APH-VAP-006 , APH-VAP-007, APH-VAP-008 , APH-VAP-009 , APH-VAP-011 , APH-VAP-012, APH-VAP-013, APH-VAP-014, APH-VAP-016 , APH-VAP-017, APH-VAP-018, APH-VAP-019

UNEVEN PROGRESS: INCOME AND ROAD TRANSPORT EMISSIONS REDUCTIONS



While Asia and the Pacific contribute significantly to transport air pollution, there's a clear trend toward reduced emissions across income levels. High-income economies have shown consistent declines since 1990.

Upper-middle-income countries saw a significant slowdown in emission growth after 2000, with more notable reductions happening between 2010 and 2018.

Lower and middle-income nations present a different picture. While they've achieved reductions in PM10 and SOx, progress on NOx emissions has lagged behind. The initial stages of adopting stricter emission standards (like Euro standards) brought significant drops in PM, black carbon, and SOx. However, the most substantial reductions in NOx emissions only came with the implementation of Euro IV and later standards.

Source: ATO analysis based on the EDGAR Database. See the following: APH-VAP-001 , APH-VAP-002 , APH-VAP-003 APH-VAP-004, APH-VAP-006 , APH-VAP-007, APH-VAP-008 , APH-VAP-009 , APH-VAP-011 , APH-VAP-012, APH-VAP-013, APH-VAP-014, APH-VAP-016 , APH-VAP-017, APH-VAP-018, APH-VAP-019

TRANSPORT AIR POLLUTION HEALTH IMPACT

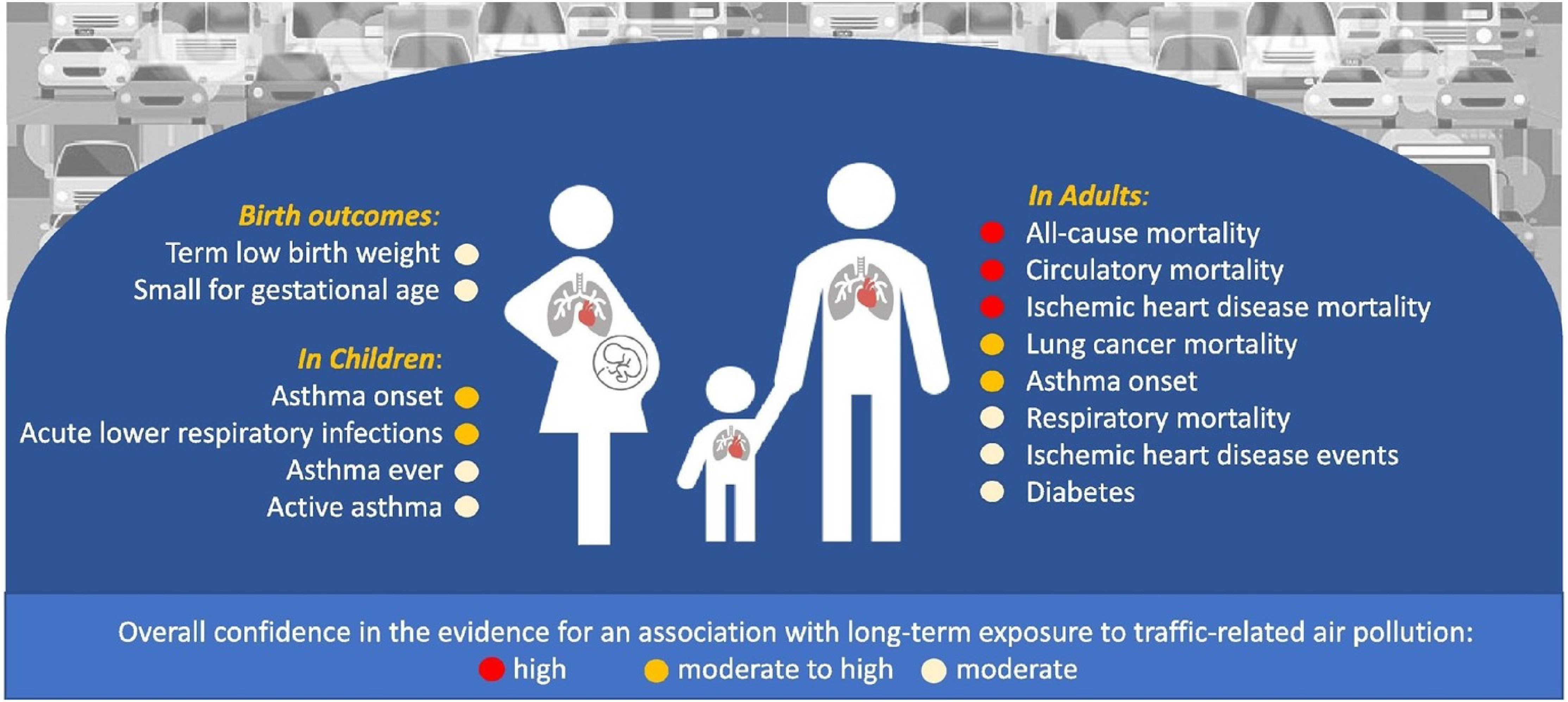
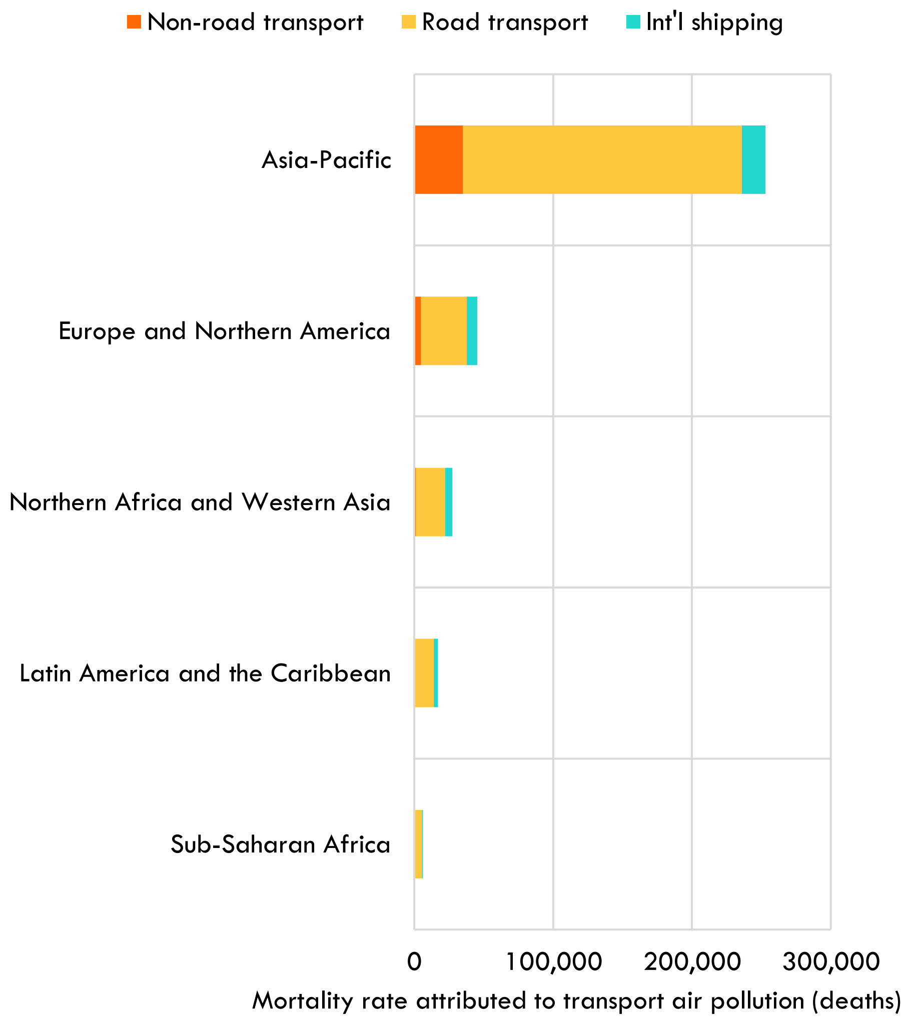


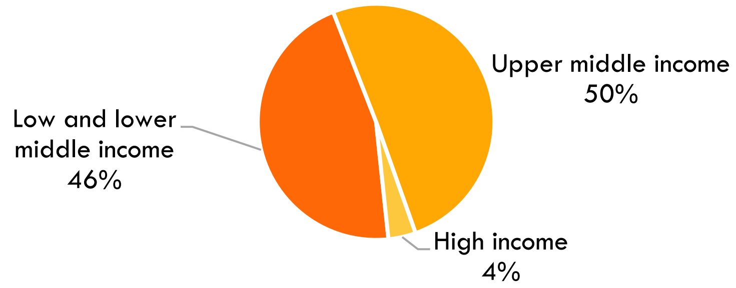
Image taken from Boogaard, H. et al (2022). [Long-term exposure to traffic-related air pollution and selected health outcomes: A systematic review and meta-analysis](#).

TRANSPORT AIR POLLUTION HEALTH IMPACT



Source: ATO analysis based on APH-AAP-002 and McDuffie, et al. (2021)

Mortality rate attributed to PM2.5 air pollution in Asia-Pacific by income



Traffic-related air pollution is a critical public health threat demanding immediate action from both the public and policymakers worldwide. Diesel vehicles are a significant source of transport air pollution in Asia and the Pacific, causing 72% of the road disease burden associated with PM2.5 and ground-level ozone pollution (ICCT, 2018). Diesel exhaust fumes are especially harmful to people in the bus industry, trucking, heavy vehicle repair, mining, and railroads.

The number of deaths due to occupational exposure to diesel engine exhaust continues to increase in most parts of Asia. While some regulations have been expanded in recent years, the impact of these changes is not well documented.

Shipping and port-related emissions worldwide constitute a significant health burden, contributing up to 0.5% of global mortality. Subsequently, about 15% of estimated premature deaths are due to PM2.5 from international shipping (ICCT, 2019). With poor data and limited research, levels of air pollution from domestic shipping and the associated health risks remain poorly understood. There is an urgent need for better data, modelling and more stringent emissions control strategies in this sector.

EXAMPLES OF TRANSPORT POLICIES AND MEASURES

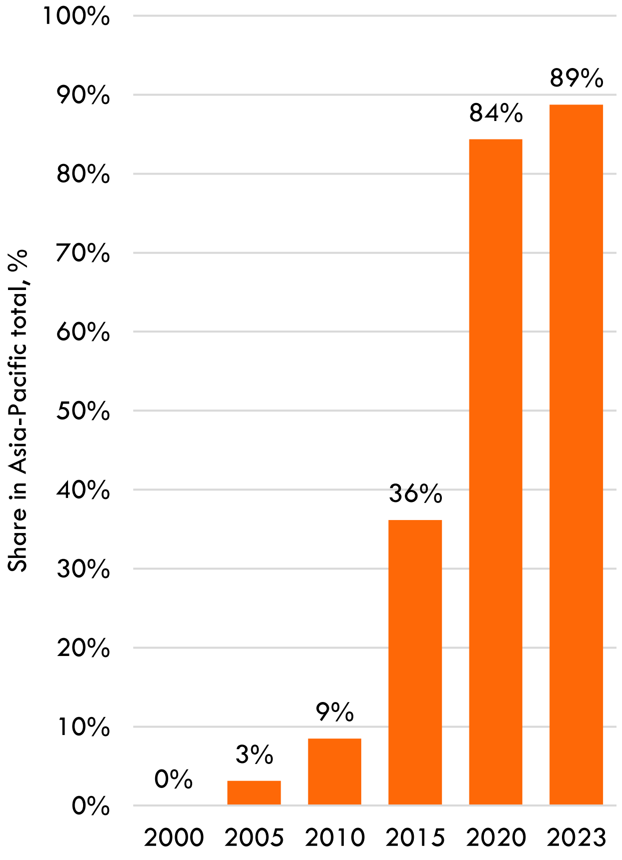
VEHICLE EMISSION STANDARDS

Over the past two decades, there has been a significant tightening of vehicle emission standards and an enhancement of fuel quality. These measures have substantially reduced emissions from newly manufactured vehicles, significantly improving air quality, particularly in urban areas and reducing associated health risks. To illustrate, in 2010, only 9% of the Asian automotive fleet operated in countries adhering to Euro 4 or higher emission standards with corresponding fuel quality. By 2023, this figure had surged to nearly 93%, signifying a notable shift towards cleaner vehicles.

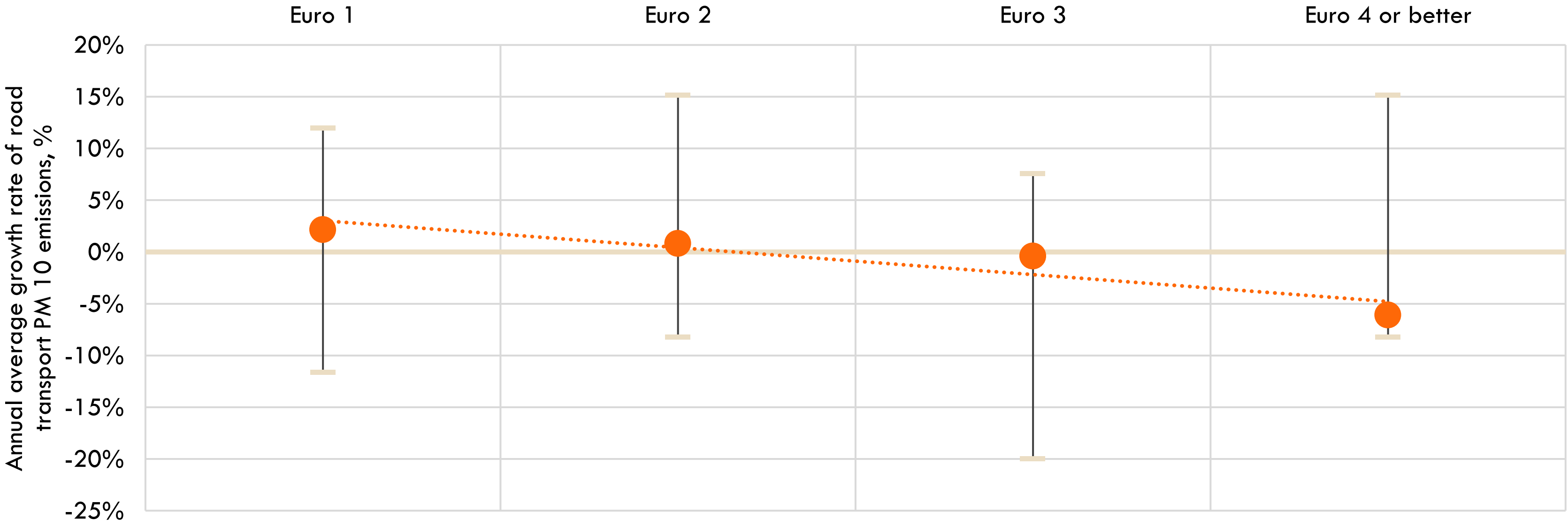
However, it is worth noting that there has been a recent stagnation in emission standards. The reduction in air pollutant emissions is not immediate, as the standards need time to offset the rapid growth in vehicle activity, and their full impact becomes apparent only when the existing vehicle fleet gradually transitions to compliant models. This vehicle fleet renewal takes time, resulting in a lagging effect in emission reductions, as depicted below.

Moreover, comprehensive legislation should encompass all modes of transportation to achieve substantial progress in mitigating air pollution. In the Asia-Pacific region, there has been relatively less progress in implementing stringent emission standards for heavy-duty vehicles and two-wheelers. This highlights the need for a more inclusive approach in addressing air quality issues across various transportation modes.

Share in vehicle registrations of economies with Euro 4 or better emission standards for LDV



Road transport PM 10 emissions growth rate with emission standards in Asia



Source: ATO analysis based on the ATO APH workbook , TAS-VEP-017, and data from Clean Air Asia, UNEP

EMISSION STANDARDS

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Bangladesh (metros)	Euro 3			Euro 4											
Bangladesh (nationwide)	Euro 2			Euro 3											
Brunei Darussalam	Euro 4														
Cambodia	Euro 1				Euro 3		Euro 4					Euro 5			
China (metros)	China 5				China 6										
China (nationwide)	China 5		China 5		China 6										
India (metros)	Bharat 4				Bharat 6										
India (nationwide)	Bharat 3	Bharat 4			Bharat 6										
Indonesia	Euro 2		Euro 4				Euro 4								
Iran	Euro 4														
Lao PDR	Euro 4														
Malaysia (gasoline)	Euro 2				Euro 4					Euro 5					
Malaysia (diesel)	Euro 2		Euro 4							Euro 5					
Myanmar (diesel)	AFAFGIT Protocol 4							Euro 4							
Myanmar (gasoline)						Euro 4									
Nepal	Euro 3	Euro 4													
Philippines (gasoline)	Euro 4														
Philippines (diesel)	Euro 2		Euro 4												
Singapore (gasoline)	Euro 4		Euro 6												
Singapore (diesel)	Euro 5		Euro 6												
Sri Lanka	Euro 2		Euro 4												
South Korea	Standards 1-4														
Thailand	Euro 4								Euro 5						
Viet Nam	Euro 2	Euro 4					Euro 5		Euro 6						

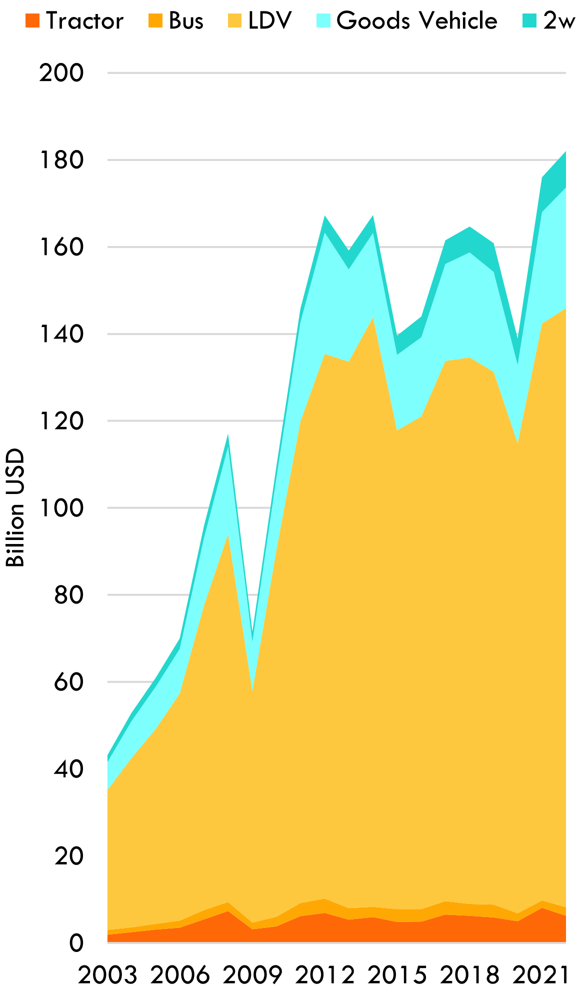
FUEL SULFUR CONTENT

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Bangladesh	350							50							
Brunei Darussalam	50														
Cambodia	1500			350[a]		50			10						
China (metros)	10														
China (nationwide)	50	10[d]													
India (metros)	50				10										
India (nationwide)	350	50			10										
Indonesia	3500	2500				500	50								
Iran	1000														
Lao PDR	500			50[k]											
Nepal	350	50			10[j]										
Malaysia	50					10[d]									
Pakistan	500[a]					10									
Philippines	50[d]														
Singapore	10														
Sri Lanka	1000		50												
South Korea	10														
Thailand	50							10							
Viet Nam	50					10[d]									

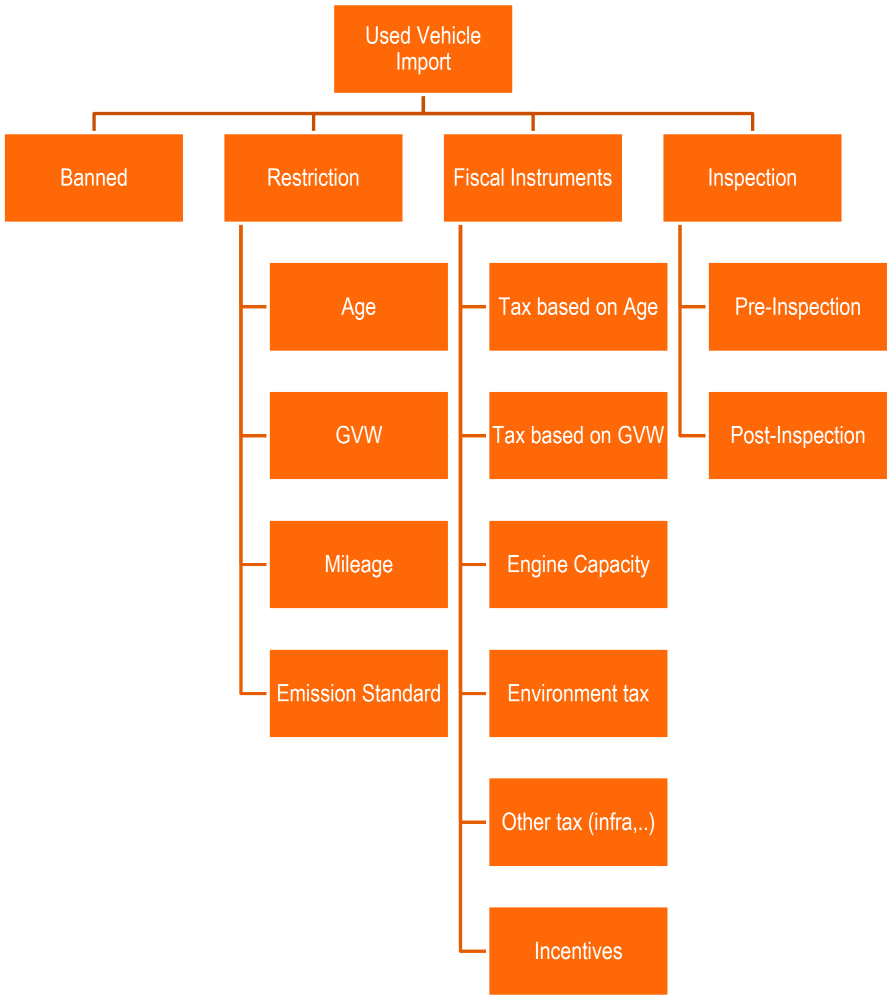
Governments implement vehicle emission limits that manufacturers meet by installing emission control technologies such as three-way catalysts, particulate filters, selective catalytic reaction converters, and exhaust-gas recirculation. However, some of these technologies, require low sulfur fuels, at 50 ppm or 10 ppm, to properly work. Thus, it is vital that the supply of clean fuels are available at scale before implementing Euro 4 or higher in the region.

TRADE OF USED VEHICLES

Vehicle imports in Asia-Pacific (Used and New)



Typology of Used Vehicle Regulations



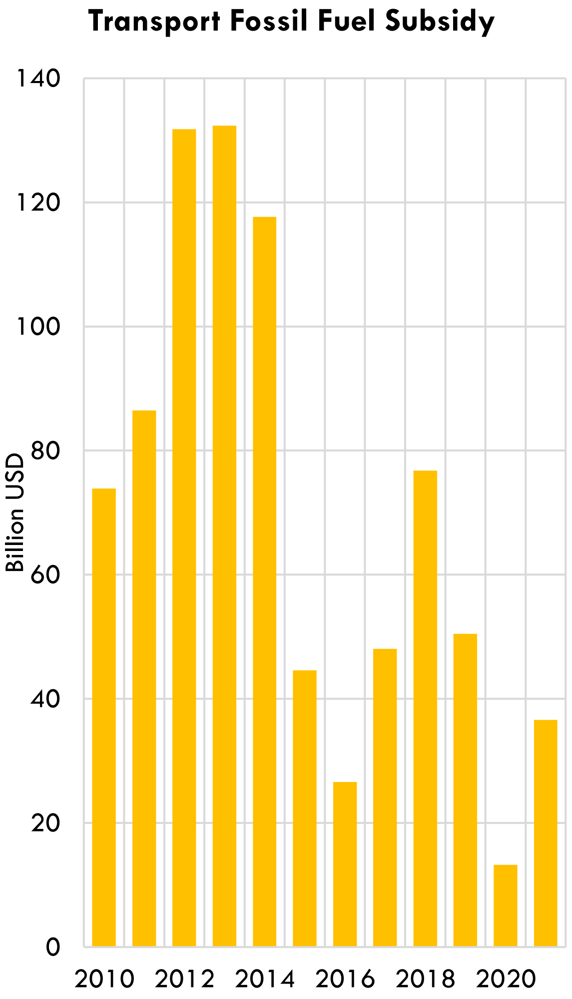
Source: Based on data contained in SEC-SEG-010, SEC-SEG-012 and typology based on UNEP

In 2022, Asia and Pacific countries imported nearly 180 billion USD worth of new and used vehicles. Used vehicles constitute a significant part of vehicle trade. Even though used vehicles play a pivotal role in air pollution, road accidents, and climate change, there are presently no international or global agreements governing the trade and circulation of these vehicles.

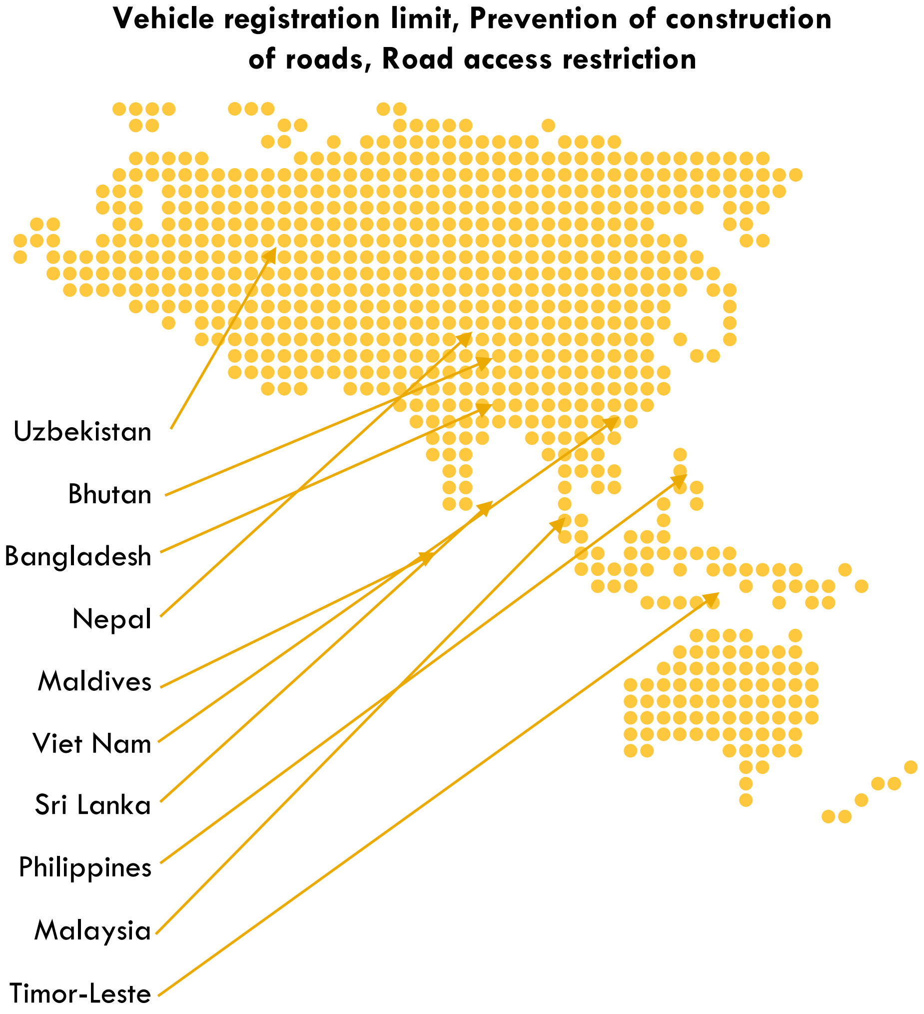
The current regulatory landscape addressing challenges related to used vehicles can adopt various approaches, including complete bans on their trade, age restrictions, financial incentives to promote behavioral change, labeling, and awareness requirements. In Asia, for example,

- India complements a used vehicle import ban with Euro VI/6 vehicle emission standard for newly registered HDVs and LDV's.
- In Sri Lanka, used buses age restrictions are 3.5 years for 10-12 occupancy, five years for 13-24 occupancy and ten years for more than 25 occupancies.
- In Fiji, age restrictions for diesel vehicles are five years or lower. In contrast, alternative fuel-powered vehicles such as LPG, CNG, Solar, Electric, and Hybrid can be imported eight years or more down
- Brunei Land Transport Department ensures technical inspection of imported vehicles before road qualification
- In Malaysia importing a used vehicle can be up to 300 per cent more expensive than the value of a new vehicle.
- In Singapore, a Carbon- Emissions- Based Vehicle Scheme (CEVS) was established in 2015. Under the CEVS all new and imported used cars with carbon emissions of less/ or equal to 135g (CO_2/km) will qualify for a rebate between US$5,000 to US$30,000, and if a car has a high carbon emission equal/ or more than 186g (C02/km) a surcharge between US$5,000-US$30,000 will be levied
- In Thailand, the import of used trucks and buses are banned under the Ministry of Commerce's Notification Regulating the Import of Used Vehicles. Brunei, Myanmar, and Viet Nam bans the import of trucks that are older than five years, while Singapore has a stricter age limit of 3 years.

MANAGING TRANSPORT DEMAND



Source: IEA



Source: ATO analysis based on survey of 15 economies. Countries considered – Bangladesh , Bhutan, Indonesia, Kazakhstan, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Timor-Leste, Uzbekistan & Viet Nam

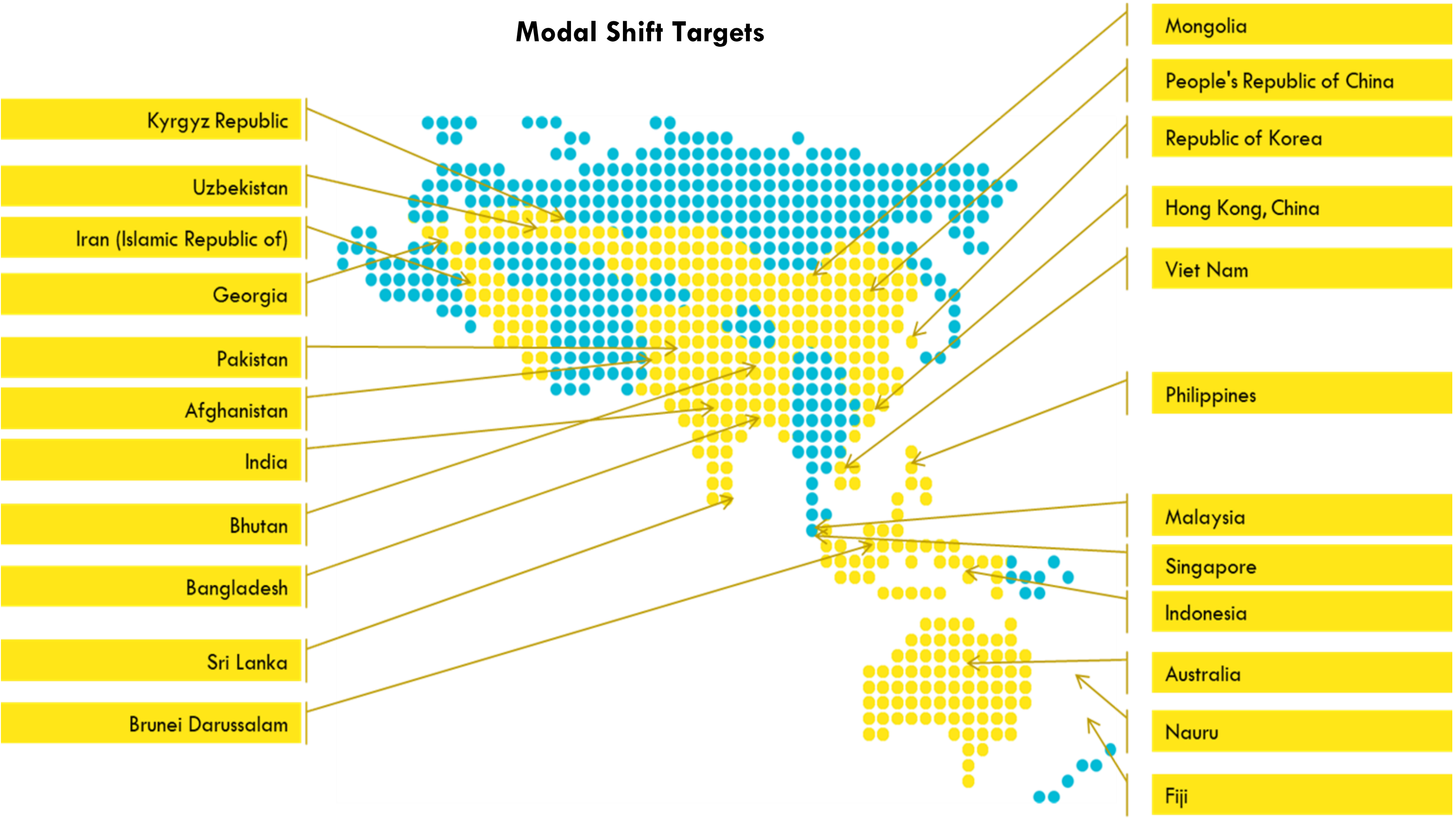
Avoid-oriented mitigation measures could require less investment but considerable political will as they aim to influence and reduce passenger and freight activity.

For example, Asia spent nearly 590 billion between 2010 and 2015 on transport sector fossil fuel subsidies. However, since adopting SDG's, fossil fuel subsidy has been reduced by more than half i.e., 250 billion from 2016 to 2021.

Till now, not many countries in Asia have taken action to limit ownership of private car ownership. However, many new policy documents refer to limiting vehicle ownership. For example,

- Bhutan plans to implement an annual vehicle capping system as indicated in its Second National Communication
- Nepal intends to limit vehicle density by controlling vehicle ownership and pricing parking as indicated in its National Transport Policy
- Viet Nam, in its Transport Strategy 2020, indicates that it will control the ownership of motorbikes and personal cars especially in Hanoi and Ho Chi Minh

MODAL SHIFT



Over the last decade, Asia has built public transit infrastructure at a massive scale to promote the modal shift in passenger and freight demand.

For example, Since 2010,

- 66% of global railway route kilometer expansion has occurred in Asia & Pacific region.
- 72% of rapid transit infrastructure construction has occurred in the Asia & and Pacific region (BRT, Metro, and LRT).

However, on per-capita levels, the infrastructure availability for modal shift is significantly limited.

23 out of 51 ATO economies have established mode share targets at an economy level in various forms and shapes (e.g., demand, share, mode, investment, passenger vs freight)

Some examples include
1)Pakistan in its National Transport Policy 2018, aims to shift road freight transport to rail by improving the integration of industries to rail stations and developing dry ports

2)Malaysia targets 40% public transport mode share in urban areas by 2030 as indicated in its Green Technology Master Plan 2017-2030

3) The Philippines in its Philippine Development Plan 2023-2028 aims to increase cycling households to 35% by 2028

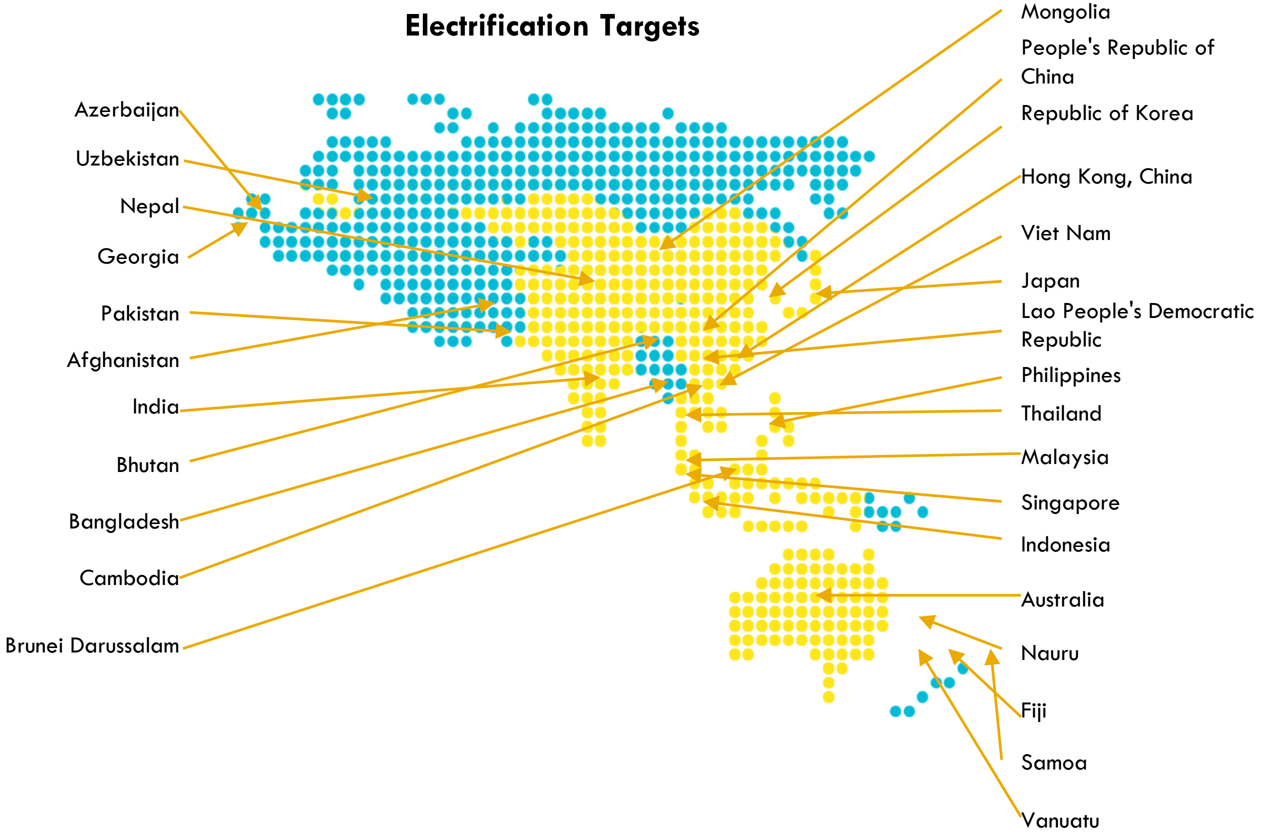
Source: ATO analysis based on official policy documents.

TRANSPORT ELECTRIFICATION

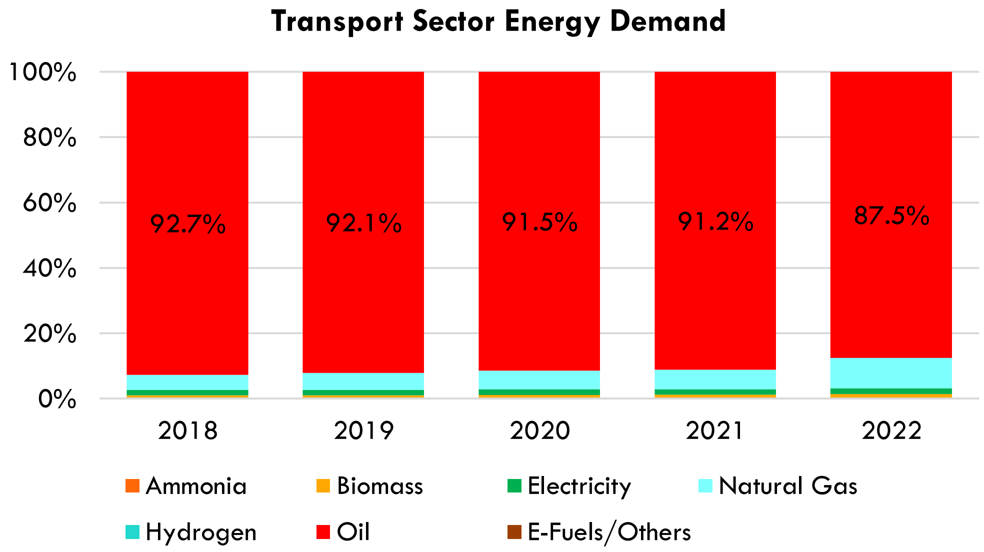
Approximately 77% of the global electric vehicle stock is in Asia. Asia is leapfrogging in terms of electric two- and three-wheeler sales. Approximately 94% of all EVs sold in Asia are electric two-wheelers and three-wheelers. Most electric two-wheelers and three-wheelers are in Asia. In terms of sales, 49% of global two-wheeler sales in 2022 were electrically powered 5% EV sales is considered the tipping point for mass EV adoption by BloombergNEF. DNV estimates suggest that Asia could cross 4% of electric vehicles in the fleet in 2023.

28 out of 51 ATO economies have established e-mobility targets in various forms. This includes - infrastructure, manufacturing, sales, and fleet-related targets.

Electricity, which constitutes about 2% of transport energy consumption, could increase to 4% by 2030 (DNV-2023)

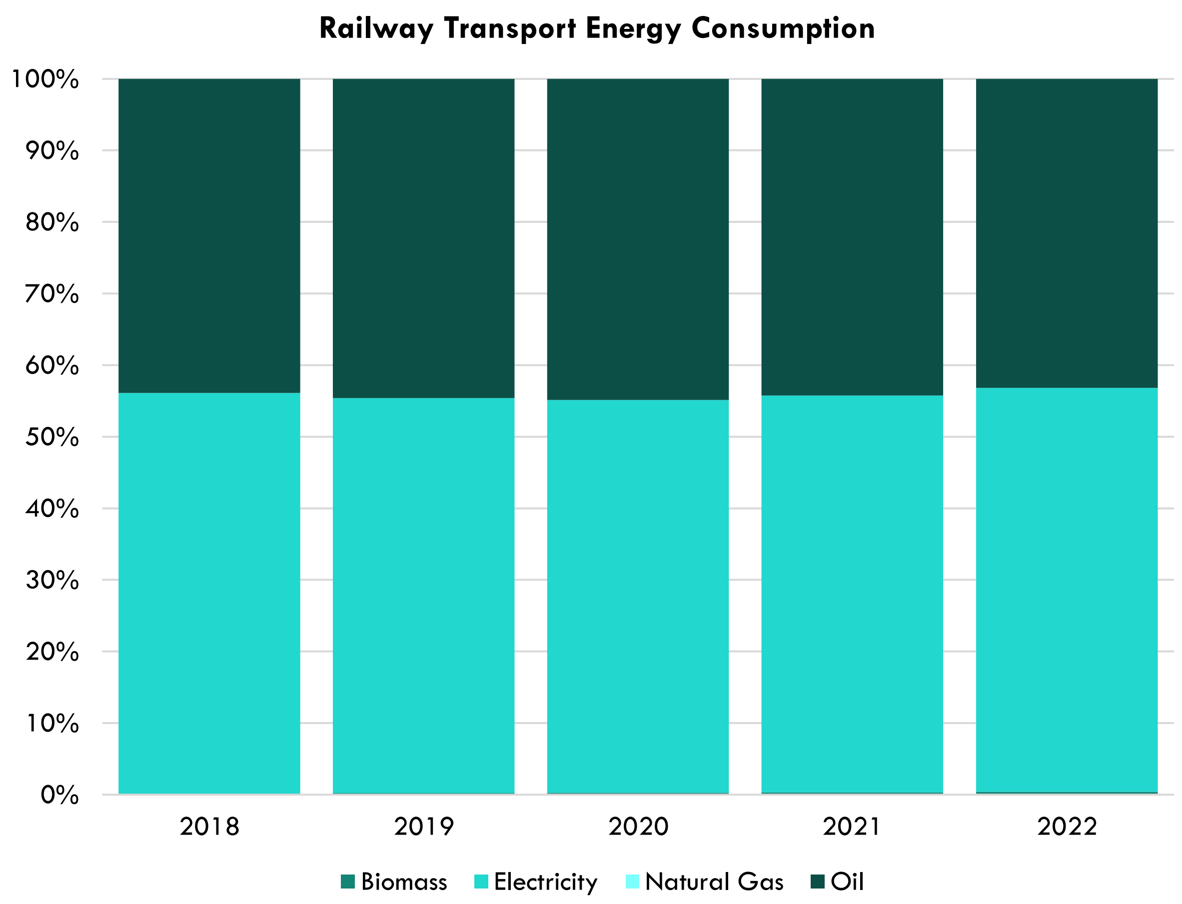


Source: *ATO analysis based on : IEA EV Outlook, DNV Energy Outlook 2023, BloombergNEF EV Outlook*



Source: *Visualised based on DNV-Energy Outlook 2023*

RAILWAY ELECTRIFICATION

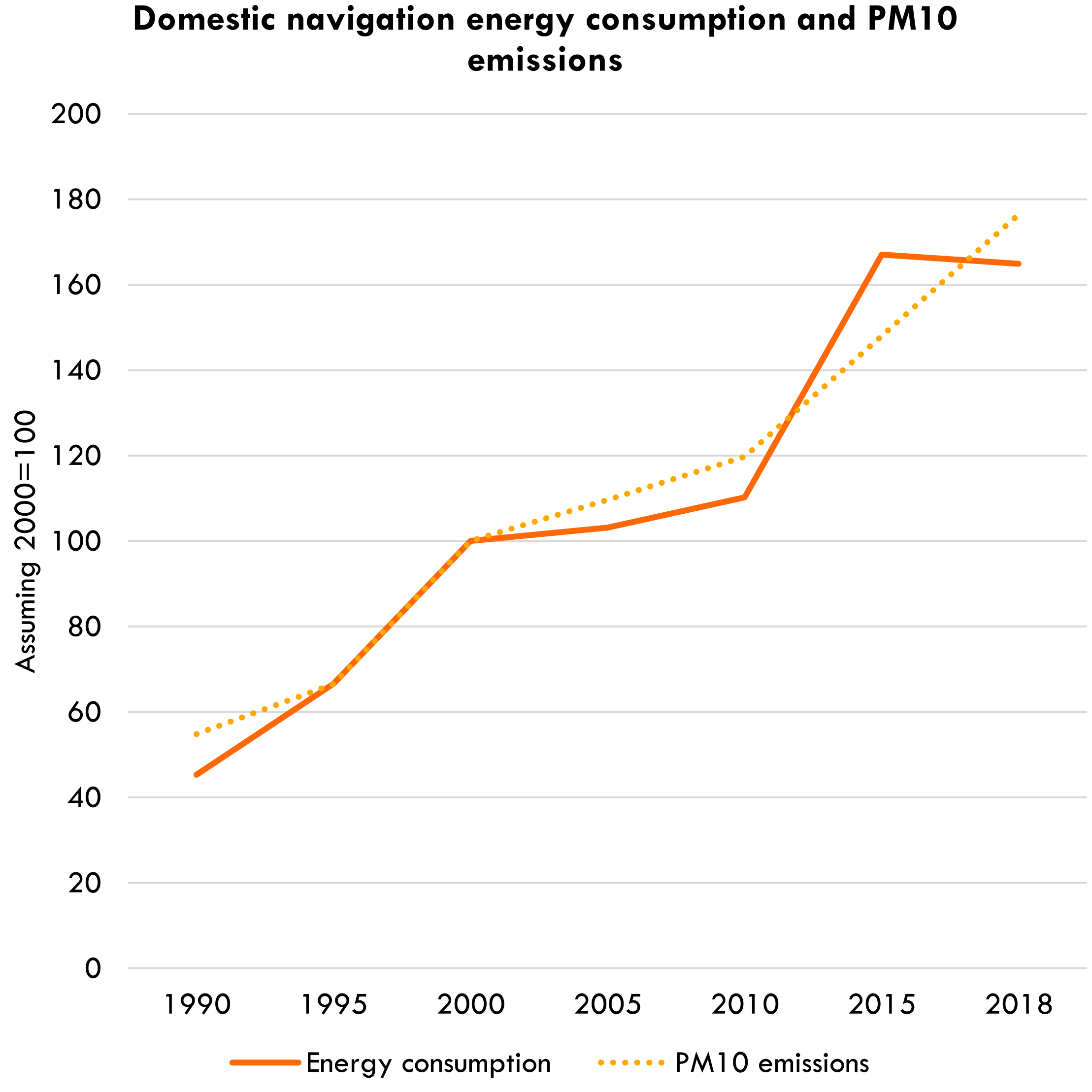


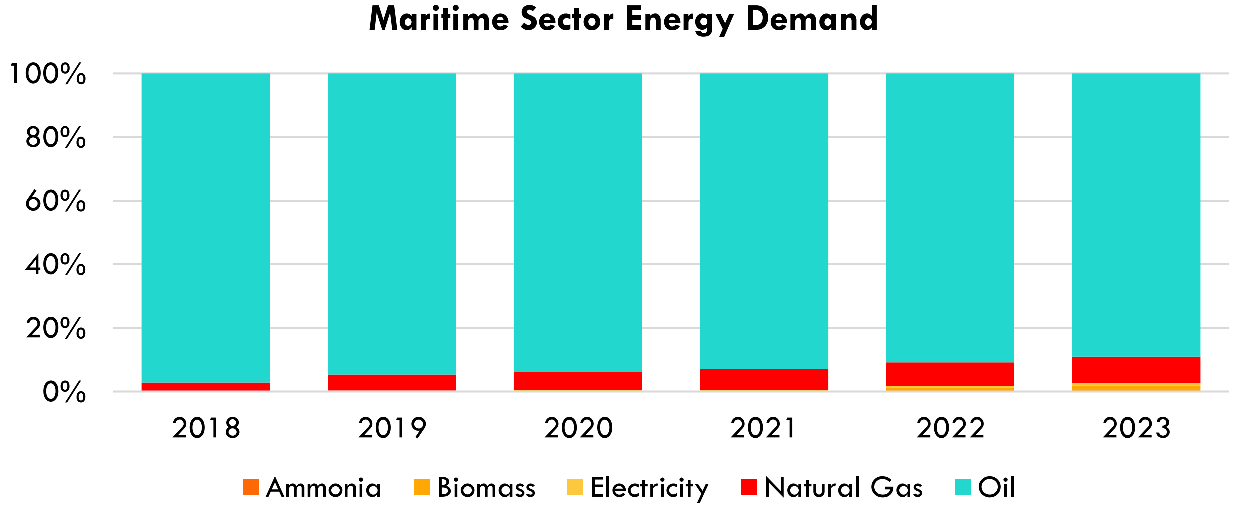
Source: Visualisation based on DNV-Energy Outlook 2023

Within the railway sector, electricity constitutes about 56% of total energy consumption in 2022. In terms of tracks, the Asian Transport Outlook estimates that railway electrification has increased from 34% of tracks in 2000 to 56% of tracks in 2020. Three-fourths of the Asian railway tracks exist in three countries – the People's Republic of China, India, and the Russian Federation. By 2020, nearly 68%, 51%, and 79% of railway tracks were electrified in the People's Republic of China, India and the Russian Federation. With 56% of tracks across Asia being electrified.

The emission trends of railway emission reductions due to electrification do not demonstrate significant emission reduction. This is mainly due to coal-intensive electricity grids in Asia. However, since 2015, the grid emission intensity has started reducing. From 2000 to 2015, the grid became more carbon-intensive at an annual rate of 0.4%. However, since 2015, the grid has been decarbonizing at -1.2% annually (improvement). The railway air pollution emissions in Asia should be reduced as the grid transitions from coal and fossil fuels towards renewable energy sources such as solar, wind, and hydroelectric power.

ENERGY TRANSITION IN DOMESTIC SHIPPING



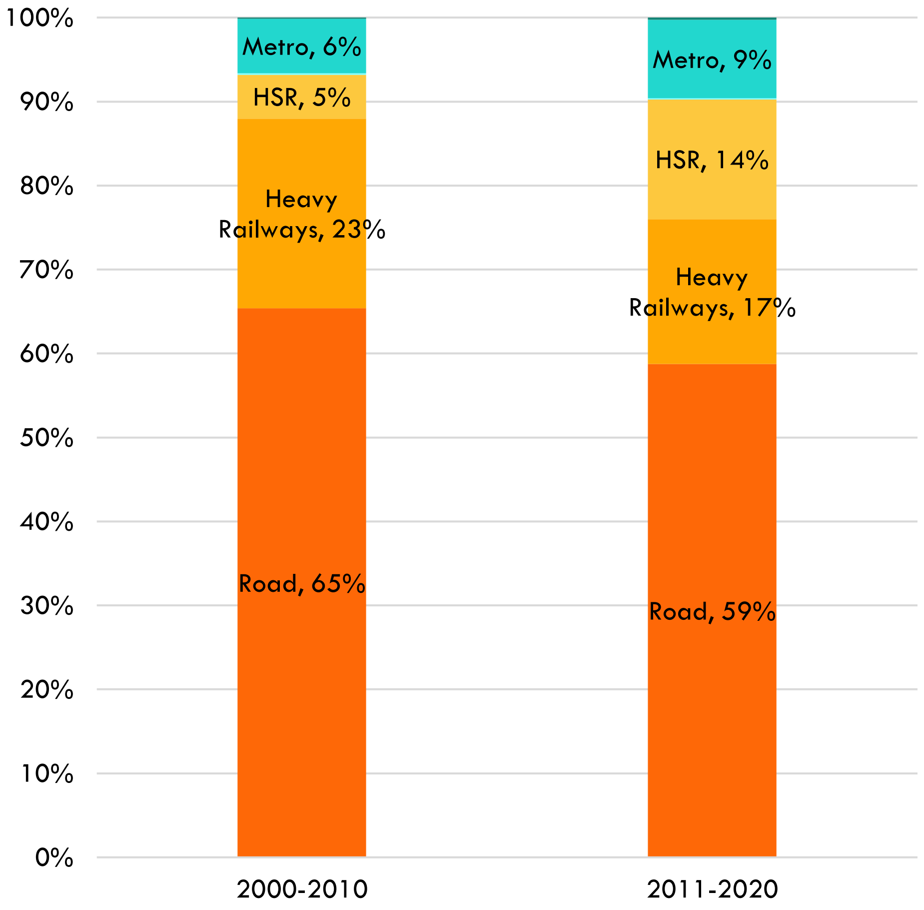


Overall, regional trends demonstrate that domestic shipping and inland waterways energy consumption is growing faster than other sub-modes in many countries. Historically, the fuel utilized in the shipping industry has been notorious for its high pollution levels compared to other transportation modes. It is typically of low quality and contains a significant amount of sulfur. Thus, shifting to low-emission fuels in shipping will be essential for emission reductions. We observe a limited shift towards natural gas in the domestic maritime industry. Similarly, the International Maritime Organization's MARPOL Annex VI sets guidelines to address emissions from shipping by adopting low sulfur fuel (0.5% sulfur content) and improving energy efficiency from ships. Many Asian countries including South Korea, Singapore, Japan, China, Philippines, Vietnam have ratified the international treaty and have corresponding mechanisms to ensure the adoption of LSFs for shipping – domestic and foreign.

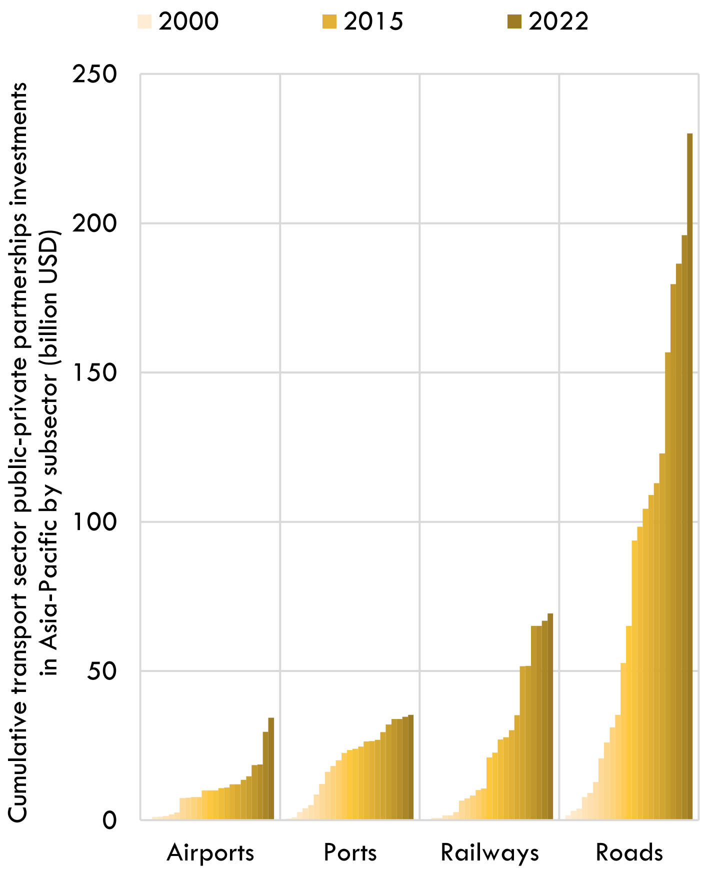
Source: ATO analysis based on data as contained in APH-VAP-003, CLC-VRE-027

TRANSPORT INVESTMENTS

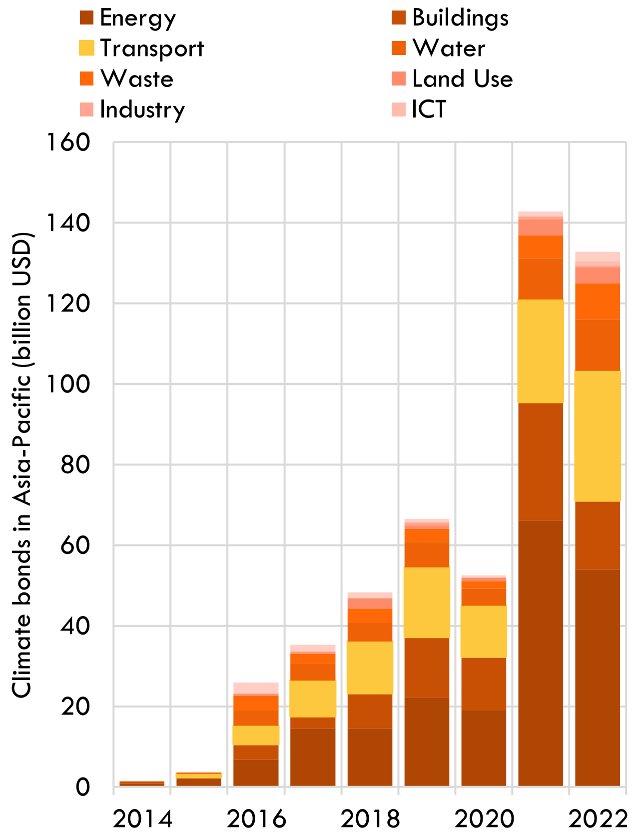
Transport Infrastructure Investment Share



Transport PPP's



Climate bonds

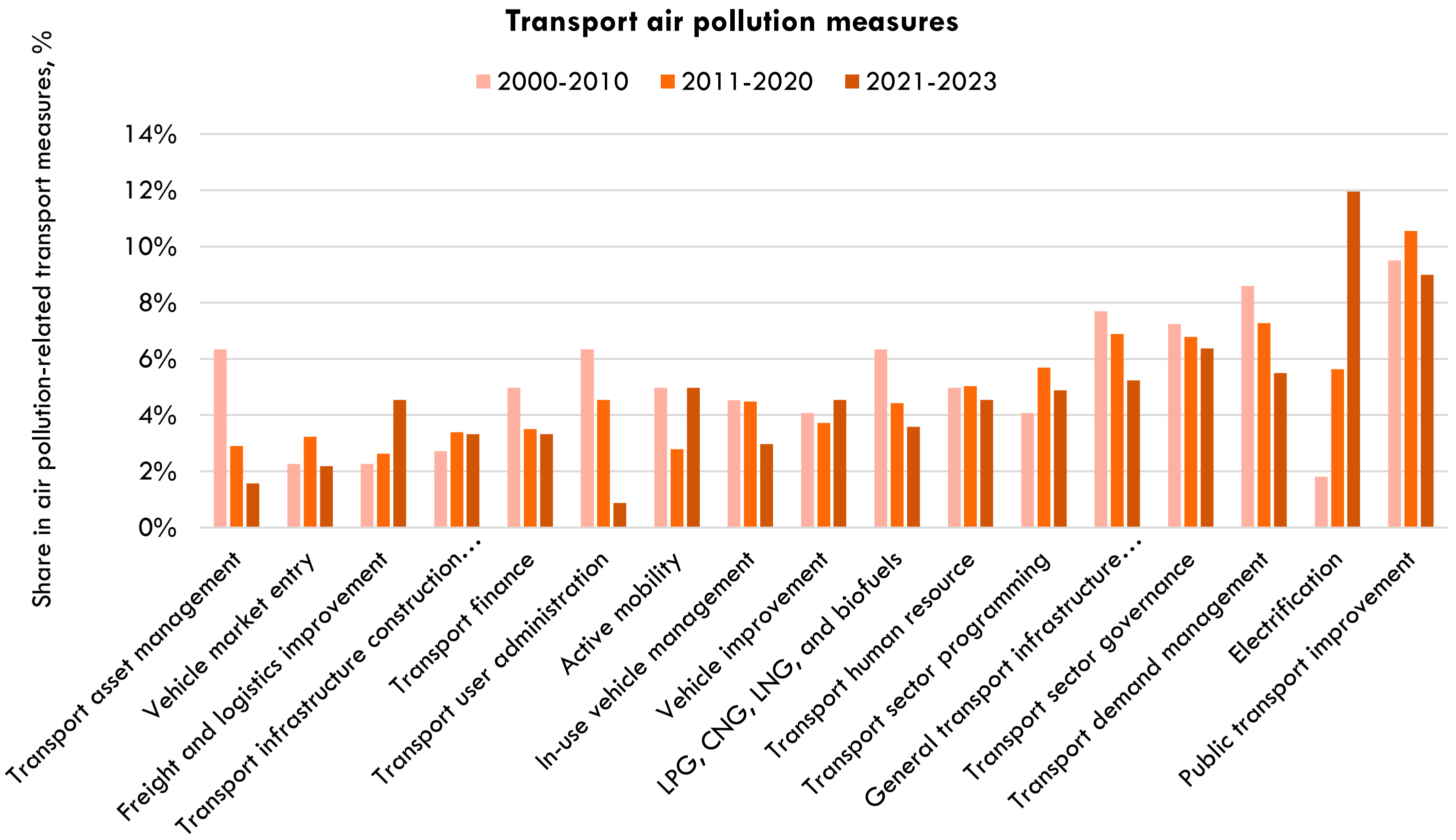


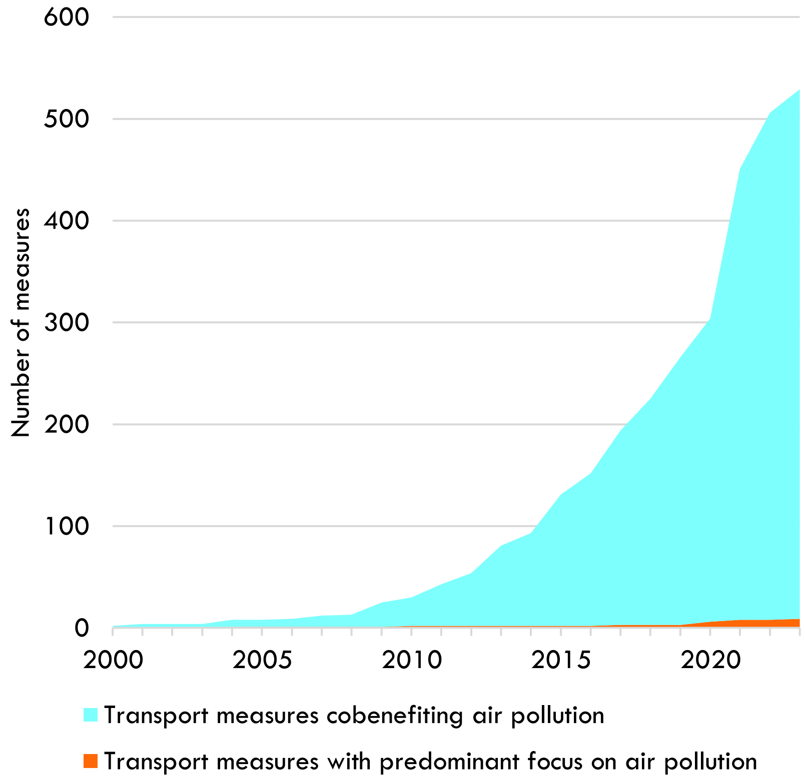
Source: ATO analysis based on SEC-TIV-003 , SEC-TIV-006 , SEC-TIV-007 , SEC-TIV-008 , SEC-TIV-009

Since 2000, Asian economies have spent about 2.4% of GDP on surface transport infrastructure. While most of the investments were allocated to road infrastructure, urban and regional rail sector investment share has increased, indicating a significant priority towards public transit. The private sector and climate finance are minor in total transport investments. However, their share is slowly increasing.

EMPHASIS ON CO-BENEFITS

GROWING FOCUS ON "CO-BENEFITS"





Based on ATO's analysis of policy documents from 15 economies. Countries considered – Bangladesh , Bhutan, Indonesia, Kazakhstan, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Timor-Leste, Uzbekistan & Viet Nam

Source: ATO analysis of national policies

Based on a survey of 15 economies, ATO finds exponential growth in transport-related statements of ambition, targets, and policy measure recommendations across economies in Asia primarily related to co-benefits, i.e., tackling climate change and air pollution. Policies and initiatives within the transportation sector typically encompass a spectrum of objectives. For instance, the public transit improvement measures tend to not only decrease travel times for transit passengers but also lead to a reduction in road crashes. Additionally, transit exhibits reduced air pollutant emissions, contributing to lower carbon dioxide (CO_2) emissions, thanks to their higher average speeds and modal shifts.

LACK OF QUANTIFICATION OF HEALTH CO-BENEFITS

In Asia,

- Only 53 publications (2000-2020) reported traffic-related air pollution effects
- Only 4 reported health impacts

Publication Year: 2003, 2006, 2007, 2008, 2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2000, 2001, 2002, 2004, 2005, 2010

Study Type: CC, CS, CE

Policy Packaging: N, Y

Method(s) Used: B, ME, MO

Country: CH, CM, CO, CZ, EC, EG, FI, FR, GR, HU, ID, IE, IR, IT, JO, LB, LT, LU, MK, MX, NL

Urban Area/City: Washington D.C., Winchester, Wuhan, Wuxi, Xiamen, Yogyakarta, Zurich

Traffic Emissions Effect Reported?: N, Y

TRAP Effect Reported?: N, Y

Human Exposures Reported?: N, Y

Health Impacts Reported?: N, Y

General Article Info										
Entry ID	Article ID	Ref ID	Title	Author(s)	Publication Year	Journal	URL to article	Study Type	Urban Policy Intervention (Raw Data)	Urban Policy Intervention
11	5	Sabapathy 2008	Air quality outcomes of fuel quality and vehicular technology improvements in Bangalore city, Indi	Sabapathy, A.	2008	Transportati	https://doi.org/10.	CS	Vehicle emission norms and fuel specificati	VER
22	9	Shin et al. 2013	Evaluation of the optimum volatile organic compounds control strategy considering the formation	Shin, H. J., Kim, J. (	2013	Envrionmen	https://doi.org/10.	CS	To improve the air quality in the SMR, the "S	VER
42	13	Aggarwal and Jain 2015	Impact of air pollutants from surface transport sources on human health: A modeling and epidemic	Aggarwal, P, & Jair	2015	Environmen	http://dx.doi.org/1	CS	2021-ALT-IV-O (Overall travel demand) One	BRT, PAC, SRE, VER, VRF
69	18	Gulia et al. 2018	Urban local air quality management framework for non-attainment areas in Indian cities	Gulia, S., Shiva Na	2018	Science of th	http://dx.doi.org/1	CS	Scenario #1: This scenario suggests restrictio	VUR
95	26	Hashad et al. 2020	Enhancing the local air quality benefits of roadside green infrastructure using low-cost, impermeal	Hashad, K., Yang, E	2020	Science of th	https://doi.org/10.	CS	Fence plus vegetation: Five main types of de	SRB, VRB
98	29	Hayashi and Sugiyama	Dual Strategies for the Environmental and Financial Goals of Sustainable Cities: De-Suburbanizatio	Hayashi, Y., & Sugi	2003	Built Enviror	https://www.jstor.	CS	Dual Strategies: De-suburbanization and Soc	DMD
180	67	Shen et al. 2008	Seasonal Variations and Evidence for the Effectiveness of Pollution Controls on Water-Soluble Ino	Shen, Z., Arimoto,	2008	Journal of th	https://doi.org/10.	CS	With concern growing over PM pollution in X	AFT, VRB
197	70	Shon and Kim 2011	Impact of emission control strategy on NO2 in urban areas of Korea	Shon, Z-H., & Kim,	2011	Atmospheri	http://dx.doi.org/1	CS	Korean government launched natural gas ve	AFT
222	78	Amann et al. 2017	Managing future air quality in megacities: A case study for Delhi	Amann, M., Puroh	2017	Atmospheri	http://dx.doi.org/1	CS	Vehicle emission limit: Euro III (Euro IV in 11	VER, AFT, PTP, ATP, PRI
244	88	Baik et al. 2012	Effects of building roof greening on air quality in street canyons	Baik, J.-J., Kwak, K	2012	Atmospheri	http://dx.doi.org/1	CS	In this study, we examine the effects of buil	VRB
246	90	Fontes et al. 2018	A proposed methodology for impact assessment of air quality trafficrelated measures: The case of	Fontes, T., Li, P., B	2018	Environmen	https://doi.org/10.	CC	Measure 1 (M1), introduced on 1st October 2	VUR
251	93	Bechle et al. 2017	Does Urban Form Affect Urban NO2 ? Satellite-Based Evidence for More than 1200 Cities	Bechle, M. J., Mille	2017	Environmen	https://doi.org/10.	CS	Three of the urban form metrics studied (co	DMD
254	95	Begum et al. 2006	Impact of Banning of Two-Stroke Engines on Airborne Particulate Matter Concentrations in Dhaka,	Begum, B. A., Bisw	2006	Journal of th	https://doi.org/10.	CS	To eliminate their impact on air quality, the	VUR
314	108	Cai and Xie 2011	Traffic-related air pollution modeling during the 2008 Beijing Olympic Games: The effects of an od	Cai, H., & Xie, S.	2011	Science of th	http://dx.doi.org/1	CS	We conducted a modeling assessment of th	VUR
318	110	Chang et al. 2009	Transport Mechanisms of Coarse, Fine, and Very Fine Particulate Matter in Urban Street Canopies v	Chang, T.-J., Kao, H	2009	Journal of th	https://doi.org/10.	CS	The study case considered in the research pr	SVA
321	112	Chelani and Devotta 20	Air Quality Assessment in Delhi: Before and After CNG as Fuel	Chelani, A. B., & D	2007	Environmen	https://doi.org/10.	CS	Use of CNG as a cleaner fuel in vehicles is or	AFT
328	115	Chen et al. 2020	Did Chinese cities that implemented driving restrictions see reductions in PM10?	Chen, S., Zheng, X.	2020	Transportati	https://doi.org/10.	CS	In this study, we only consider cities that use	VUR
332	117	Chen et al. 2014a	The influence of governmental mitigation measures on contamination characteristics of PM2.5 in E	Chen, Y., Schleiche	2014	Science of th	http://dx.doi.org/1	CS	Traffic restriction measures included: (1) im	VER, VUR
363	131	Dhondt et al. 2012	Integration of population mobility in the evaluation of air quality measures on local and regional s	Dhondt, S., Beckx,	2012	Atmospheri	http://dx.doi.org/1	CS	The impact of a fuel price increase policy on	FUT
406	147	Ghasemian et al. 2017	The influence of roadside solid and vegetation barriers on near-road air quality	Ghasemian, M., Ar	2017	Atmospheri	https://doi.org/10.	CS	B: 2) solid barrier with height of 1:5H and thi	SRB

https://carteehdata.org/library/dataset/urban-policyintervention-f08c

Slide taken from Tamayo, E. & Abad, R. (2023, March 24). Transport policies to reduce air quality and climate pollutants [Powerpoint slides]. Clean Air Asia.

*Urban policy interventions to reduce traffic-related emissions and air pollution: A systematic evidence map (Khreis, et al. 2023)

KEY TAKEAWAYS

The knowledge product on transport-related air pollution in Asia highlights the urgent need for attention to this critical challenge due to its adverse effects on air quality, public health, and climate change. The product assesses the progress made in reducing air pollution from transportation in Asia, examining trends, initiatives, policies, technologies, and behavioral shifts. It originates from the Asian Transport Outlook (ATO) initiative, aiming to build a comprehensive knowledge base on transport in the region. Key findings include:

- **Emission Trends**: While transport-related air pollutant emissions have increased over time, not all modes have contributed equally. Road transport historically has been a significant contributor, but emissions have shown regional reductions in recent years due to vehicle emission standards and improved fuel quality. However, emissions from domestic waterways and inland shipping have increased notably. However, the trends vary significantly among sub-regions and countries.

- **Progress and Challenges**: Despite overall reductions, challenges persist, particularly regarding NOx emissions. Progress has been uneven across income levels, with high-income economies showing consistent declines since 1990. Lower and middle-income nations have made progress but face challenges, particularly in reducing NOx emissions.

- **Diesel Vehicles and Shipping**: Diesel vehicles are a significant source of air pollution, particularly in the bus industry, trucking, and railroads. Shipping and port-related emissions also contribute significantly to health burdens.

- **Regulatory Measures**: Stricter vehicle emission standards and improved fuel quality have led to reductions in emissions from newly manufactured vehicles. However, implementation challenges remain, particularly regarding used vehicles and heavy-duty vehicles.

KEY TAKEAWAYS (2)

- **Policy Initiatives**: Various policy initiatives aim to mitigate air pollution, including bans on the trade of used vehicles, emission standards, and incentives for cleaner vehicles. However, challenges such as limited infrastructure for public transit and incomplete legislation across transportation modes persist.
- **E-mobility**: Asia leads in electric vehicle adoption, particularly in the two- and three-wheeler market. However, targets for e-mobility vary across economies.
- **Railway Electrification**: Railway track electrification has increased significantly, but emissions reductions have been limited due to coal-intensive electricity grids. Transitioning to renewable energy sources is crucial for reducing railway emissions.
- **Investment Trends**: Surface transport infrastructure investments have primarily focused on road infrastructure, but there's an increasing priority towards public transit. Private sector involvement and climate finance are slowly increasing.
- **Knowledge gaps:** More research and data are needed on disaggregated emissions from different modes, energy consumption, and health impacts of air pollution